INTRODUCTION

A galvanometer-based laser scanning system is an essential element in many laser additive manufacturing technologies. Fast, accurate laser scanning with smart controls to synchronize the laser and scanning system can effectively improve build part quality and job throughput. This results in a reduction in the cost of each manufactured part, enabling many industries to take advantage of additive manufacturing.

EXPERIMENTS

Experiment Set Up

Objectives:

1: Uniform Laser Density
- Extract a single layer from the 3D model.
- Use both ScanPack control and Velocity Based Laser Modulation technique to mark the outline and hatch solid areas.

2: Throughput Improvement
- Mark all layers of the 3D model using both conventional and ScanPack control.
- Compare the time required to complete the entire job (job throughput).

TECHNOLOGY

Digital Scanning Technology

Optimized Galvanometer, Servo Driver, Mirror, Control and Communication in a single, integrated platform.

- 50 rad-optical/s (30mm scan head)
- 24-bit command resolution (e.g. 17mm in 400mm field versus 4.5µm for 16-bit)
- < 10 µm patterning accuracy in 400x4000mm field
- Low long term drift and thermal stability for stable, 24/7 performance

Smart Control Techniques For Uniform Laser Density

I. ScanPack Maintains Constant Velocity
- Accuracy-oriented trajectory planning
- True skywriting: automatic optimization based on local geometry
- End Velocity Control

II. Velocity Based Laser Modulation
- Modulate laser frequency, power or pulse width based on scanner speed variation to maintain constant energy deposition on material.

RESULTS

I. Uniform Laser Density with ScanPack Constant Velocity

Location 1: Corner in the outline Note: hatch deliberately removed

Location 2: Edge of Hatch lines Note: outline deliberately removed

II. Uniform Laser Density with Velocity Based Laser Modulation

Outcome of corner marking using conventional control with and without laser modulation of frequency

III. 23% Improvement in Job Throughput with ScanPack Control

Thin Wall Structure Job Parameters

<table>
<thead>
<tr>
<th>Conventional</th>
<th>ScanPack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mark Speed</td>
<td>2700 mm/s</td>
</tr>
<tr>
<td>Jump Speed</td>
<td>2700 mm/s</td>
</tr>
<tr>
<td>Mark Delay</td>
<td>300 µs</td>
</tr>
<tr>
<td>Jump Delay</td>
<td>150 µs</td>
</tr>
<tr>
<td>Poly Delay</td>
<td>75 µs</td>
</tr>
<tr>
<td>Job Throughput</td>
<td>37.4 s</td>
</tr>
</tbody>
</table>

CONCLUSION

We present digital scanning technology to meet the accuracy, speed and stability requirements for additive manufacturing. We also demonstrate two control techniques to deliver uniform laser density on the material, which greatly improves the quality of the manufactured part. Additionally, ScanPack control can improve job throughput by 20-30% over conventional control.

REFERENCES